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Machine learning for combined scalar and spectral longitudinal phase space reconstruction

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Longitudinal beam diagnostics are a useful aid during tuning of particle accelerators, but acquiring them usually requires destructive and time intensive measurements. In order to provide such diagnostics non-destructively, computational methods allow for the development of virtual diagnostics. Existing Fourier-based reconstruction methods for longitudinal current reconstruction, tend to be slow and struggle to reliably reconstruct phase information. We propose using an artificial neural network trained on data from a start-to-end beam dynamics simulation to combine scalar and spectral information in order to infer the longitudinal phase space of the electron beam. We demonstrate that our method can reconstruct longitudinal beam diagnostics accurately and provide the reconstructed data with adaptive resolution. Deployed to control rooms today, our method can help human operators reduce tuning times, improve repeatability and achieve pioneering working points. In the future, ML-based virtual diagnostics will help the deployment of feedbacks and autonomous tuning methods, working toward the ultimate goal of autonomous particle accelerators.

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Footnotes

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Yes

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